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UNITED STATES PATENT APPLICATION

FOR

NOZZLE

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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates to the field of injection systems in general and to the field of providing a nitrous oxide/fuel mixture to a combustion cylinder, in particular.

2. RELATED ART

In internal combustion engines, a mixture of air and fuel is burned in a combustion chamber (cylinder), with the force generated by the combustion being utilized to provide mechanical energy. The mechanical energy may be used to turn a drive shaft, for example. Typically, the air and the fuel are mixed in a device such as a carburetor prior to their introduction into the cylinder. In order to increase the efficiency of the combustion process, it is often desired to "inject" the fuel into the combustion chamber. In an injection system, the fuel and the air are separately introduced to the combustion chamber. There, mixing occurs and, ideally, the fuel is vaporized. Such vaporization maximizes the surface area of fuel exposed to oxygen at a given time. This increases the speed and efficiency of combustion.

For high performance it is sometimes desired to introduce nitrous oxide into the combustion chamber along with the fuel. The nitrous oxide operates as a source of oxygen for the oxidation (i.e., combustion) of the fuel. The nitrous oxide/fuel mixture is more combustible than air and fuel alone, leading to greater energy in the burn and consequently increased mechanical energy. In order to maximize the efficiency of the nitrous oxide/fuel mixture combination, it is desired to inject the mixture in an atomized form to form an aerosol comprising a multitude of small fuel droplets. In addition, it is desired to utilize the nitrous oxide as a means of atomizing the air/fuel mixture.

In a device described in U.S. Patent Nos. 4,798,190 and 4,827,888, assigned to the assignee of the present invention, a nozzle is provided that mixes and atomizes fuel with nitrous oxide. The nozzle comprises a Y-shaped housing having a pair of inlet ports and a single outlet port. One inlet port introduces fuel to the nozzle through a fuel line that extends the length of the nozzle, terminating at the outlet port. The second inlet port is used to introduce nitrous oxide into a hollow sleeve of the nozzle surrounding the fuel channel and ultimately exiting at the outlet port. The nitrous oxide is introduced at a higher pressure than the fuel, such that as the nitrous oxide exits past the end of the fuel line at the outlet port, it creates a vacuum which aids in drawing the fuel from the line. Because the fuel and the nitrous oxide are permitted to impinge upon each other within the confines of the nozzle, the mixing creates a high impact pressure near the nozzle exit. This in turn leads to chaotic turbulence in which the mixing is not even and the atomization non-optimal.

Accordingly, it is desired to provide a nozzle configuration that leads to a finer atomization of the fuel droplets and a more even mixing of the nitrous oxide and the fuel.

SUMMARY OF THE INVENTION

An injection nozzle utilizing nitrous oxide to form an aerosol with fuel in a combustion chamber is disclosed. The nozzle has a body defining a fuel channel and a nitrous oxide tube that does not communicate with the fuel channel within the body of the nozzle. The fuel channel terminates in a plurality of radially spaced fuel outlet ports surrounding an outlet port of the NO_2 tube. Fuel is introduced in the fuel channel at a pressure of approximately 3 - 12 p.s.i. Nitrous oxide is introduced in the nitrous oxide tube at a high pressure of approximately 500 - 1000 p.s.i. The nitrous oxide tube terminates flush with an outlet end of the body of the nozzle and centrally dispose relative to the plurality of annularly spaced fuel outlet ports. As a result, the NO_2 forms a jet that shears each of the fuel streams, thereby forming an aerosol with the fuel within a large volume of the combustion chamber and thus causing it to burn more efficiently. The central location of the NO_2 jet relative to the plurality of fuel ports increase the efficiency of the shearing and subsequent aerosol formation over prior art nozzles.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features as well as advantages of the different embodiments of the invention will be apparent by referring to the drawings, detailed description and claims below, where:

Figure 1 is a partial cut away plan view of an injection nozzle of one embodiment of the invention.

Figure 2 is a plan view of the outlet end of one embodiment of the invention.

Figure 3 is a cross-sectional view of one embodiment of the invention.

Figure 4 is a magnified partial sectional view of a portion of the tube and elongated region of the body member.

Figure 5 is a cut away partial sectional view of a nozzle of an alternative embodiment of the invention with fuel and oxidizing agent inlet ports shown in phantom lines.

Figure 6 is a magnified partial sectional view of the embodiment of Figure 5.

Figure 7 is a cross-sectional plan view of the embodiment of Figure 6.

Figure 8 is a partial cut-away prospective sectional view with an elongated region of one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a partial cut away plan view of an injection nozzle of one embodiment of the invention. A body member 10 having an elongated region 13 with a threaded region 16 disposed thereon defines an angular bore 21 and a straight bore 22 therein. The angular bore 21 intersects the straight bore 22 within body member 10. The elongated portion 13 terminates in an outlet end 9. Threaded region 16 permits easy installation in a manifold port 24 such that outlet end 9 outlets into combustion chamber 25. Coupling members 17 and 18 engage a threaded region in the straight and angular bores respectively. Coupling member 18 defines a fuel inlet port 12 in fluid communication with the angular bore 21 and engages to a threaded region (not shown) of the angular bore 21. Coupling member 17 defines an oxidizing agent inlet port 11 and engages a threaded region of the straight bore 22. A tube 20 is coupled to coupling member 17. Tube 20 extends from coupling member 17 the remaining length of the straight bore and is approximately concentric therewith. The tube 20 terminates substantially flush with outlet end 9 of the body member 10. Tube 20 defines the oxidizing agent flow path 23 and provides for constant fluid communication between inlet port 11 and outlet end 9 of the body member 10. The straight bore 22 of the body member 10 in conjunction with tube 20 define an annular region around the tube which is in fluid communication with the angular bore 21 such that when fuel is flowing, the annular region between the tube and the body walls defining the straight bore 22 is substantially filled with fuel from the intersection of the strait bore 22 and angular bore 21 to the outlet end 9.

Figure 2 is a plan view of the outlet end of one embodiment of the invention. Outlet end 9 has a central oxidizing agent port 30, the circumference of which is defined by the end of tube 20. A plurality of fuel outlet ports 31 are defined by body member 10 and radially spaced around the central oxidizing agent outlet port 30. Accordingly, in operation, nitrous oxide is expelled from central oxidizing agent outlet port 30 under high pressure, typically in the range

of 500 - 1000 p.s.i. Because the oxidizing agent chamber 25 is straight, maintaining the pressure of the oxidizing agent through the nozzle is simplified as there are no bends in the flow path to cause a pressure drop [**is this true?**]. Concurrently, a fuel stream trickles out ports 31 typically at 3 - 12 p.s.i. of each of the plurality of fuel outlet ports 31. Upon exiting the tube 20, which is flush with outlet end 9, i.e., approximately coplaner with outlet ports 31 of body member 10, the nitrous oxide rapidly expands shearing each of the fuel streams thereby forming an aerosol of nitrous oxide and fuel. Because the fuel ports are annularly spaced around the oxidizing agent port, the efficiency of aerosol formation and, therefore, combustion is greatly increased over prior art devices in which the oxidizing agent jet impinged on a single larger fuel stream.

Figure 3 is a cross-sectional view of one embodiment of the invention perpendicular to the view of Figure 1. Coupling member 17 engages threaded region 32 of straight bore 22 in body member 10. Tube 20 may, for example, be welded to coupling member 17 or formed integrally therewith. Angular bore 21 intersects the straight bore 22 to provide the fluid communication described above.

Figure 4 is a magnified partial sectional view of a portion of the tube and elongated region of the body member. Tube 20 engages the walls 33 of the central opening in the outlet end of body member 10 such that substantially no fuel leaks around the tube along walls 33. Fuel outlets ports 31 provide a path of least resistance for fuel in the annular region surrounding the tube 20.

Figure 5 is a cut away partial sectional view of a nozzle of an alternative embodiment of the invention with fuel and oxidizing agent inlet ports shown in phantom lines. The fuel introduction aspect of this embodiment is the same as in the embodiment shown in Figure 1. Specifically, a coupling member 18 defines a fuel inlet port 12 which is disposed in fluid communication with an angular bore 21 defined by body member 110. Angular bore 21

intersects straight bore 122 which is also defined within body member 110. Bore 122 has a threaded region 132 for engagement by coupling member 117. Coupling member 117 defines an oxidizing agent inlet port 111 and is coupled to tube 120 which provides a flow path 123 for an oxidizing agent introduced. In this embodiment, bore 122 is a through bore penetrating outlet end 109 of body member 110. The tube 120 has disposed on its outlet end a flange member 200. The flange member in conjunction with the walls of straight bore 122 define annular fuel outlet ports around the oxidizing agent outlet port defined by tube 120. Notably, the longitudinal dimension of flange member 200 can be arbitrarily long provided there remains sufficient fluid communication between angular bore 21 and each of the annularly spaced fuel ports defined by the conjunction of the flange member 200 and the walls of straight bore 122. In any event, at the outlet end 109 the edges of flange member 200 should engage the walls of straight bore 122 such that fuel seepage does not occur at the points of engagement. Again, the fuel outlet ports and the nitrous outlet port are substantially coplaner. In a minor variant of this embodiment body member 110 may have a lip at outlet end 109 against which flange member 200 abuts.

Figure 6 is a magnified partial sectional view of the embodiment of Figure 5. Tube member 120 having flange member 200 attach thereto is substantially flush with outlet end 109 of body member 110. Additionally, flange member 200 engages the walls defining straight bore 122 within body member 110.

Figure 7 is a cross-sectional plan view of the embodiment of Figure 6. Flange member 200 is shown coupled to tube 120 and engaging the walls of straight bore 122.

Figure 8 is a partial cut-away perspective sectional view with an elongated region of one embodiment of the invention. In Figure 8 an alternative flange member 201 is coupled to tube 120. Flange member 201 engages the walls of bore 122 throughout its entire circumference. Plurality of fuel outlet ports 131 are defined by flange member 201 and radially

spaced around oxidizing agent outlet port 130. Again flange member 201 can have an arbitrarily great longitudinal dimension provide fluid communication between each fuel outlet port 131 and the fuel entering the angular bore 21 is maintained.

While the above described embodiments can be manufactured from many different metals including brass and aluminum, it is preferred that the body member, the coupling members and the tube be stainless steel. Machining the above nozzle from stainless steel results in a nozzle having improved durability in the high stress environment in which the nozzles are used.

In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident that various modifications and changes can be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. Therefore, the scope of the invention should be limited only by the appended claims.